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CONTENTS

LAWS OF TURBULENT FLOW IN OPEN CHANNELS

The first attempts of hydraulic engineers to formulate the laws of flow in open channels, such as canals and rivers, date back to the latter part of the eighteenth century. At this time Chezy proposed his famous formula for determining the velocity of flowing water in terms of the dimensions of the channel and the slope of the water surface. This formula contained a quantity, the so-called Chezy coefficient, the value of which was to be determined by experiments. Chezy believed his coefficient was a constant having a value independent of the size of channels or of the nature of their surfaces. It took nearly half a century to discover that this belief was wrong.

In 1857 Darcy and Bazin commenced a comprehensive series of well-planned tests in order to place the laws of flow in open channels on a firm foundation. As a result of the tests, Bazin was able to show that the Chezy coefficient was a quantity, the magnitude of which depended not only on the size of a channel but also on the nature of the channel bottom and side surfaces. Practically all of the formulas used by hydraulic engineers today, both here and abroad, can be traced back to Bazin's work.

These formulas, which are in common use, are defective in form from the strict scientific viewpoint. As a result, there is always some uncertainty in their application. For example, when model experiments involving flow in open channels are conducted, the transfer of the results from the model test to the actual structure is either very difficult or is of doubtful value.

A paper by G. H. Keulegan in the Journal of Research for December (RP1151), on the general problem of flow in channels, is based on the modern theory of turbulence and, in particular, on the formulation of this theory which has proved its utility in the study of flow in circular pipes. The formulas for velocity in open channels, and to a certain extent those

[1] Published with approval of the Director of the Budget.

for velocity distribution, are derived in forms almost identical with those for circular pipes. Using Bazin's test data, the applicability and utility of these formulas are established.

It is also shown how the Manning formula, one of the earlier type now in common use, is an approximation to the rational form which is valid throughout a certain restricted range of conditions.

STRENGTH OF A RIVETED STEEL RIGID FRAME

In recent years rigid frames have found increasing use in building bridges, auditoriums, hangars, warehouses, etc. In this type of construction the ends of component members are connected in such a way as to prevent relative rotation. Often a considerable saving in material results from the use of the rigid frame, and advantages of beauty and convenience may also be important.

Heretofore there has been no satisfactory method of computing the stresses in the knees, that is, at the junctions of component members, and for this reason many designers have been reluctant to use rigid frames.

The Bureau, with the cooperation of the American Institute of Steel Construction, has carried out an investigation on the strength of rigid frames, and a paper (RP1161) by A. H. Stang, Martin Greenspan, and W. R. Osgood, in the December Journal of Research, gives the results of the tests on a rigid-frame specimen with curved inner flange, donated by the American Bridge Co.

The distribution of stress in the specimen was determined from strain measurements. As the magnitude of the stresses in the outer corner was in question, duplicate tests were made with and without outer-corner reinforcement. It was found that the stresses in the outer corner were generally small and that the presence or absence of the reinforcement had little effect on the distribution of stress in the specimen. It was also found that stiffening the web did not alter the distribution of stress appreciably. A theory for the distribution of stress in the knee was developed, and the values calculated from this theory were in satisfactory agreement with the measured stresses.

The maximum load that could be sustained by the rigid-frame specimen was also determined.

SURFACE TREATMENT FOR PROTECTING STEEL AGAINST CORROSION

Some of the factors affecting the protective value of paints for steel and galvanized surfaces are being studied at the Bureau, using accelerated laboratory corrosion tests supplemented by outdoor exposure. When steel is used in the form of light-gage sheet, protection is a matter requiring serious consideration, particularly in inaccessible locations, such as the interior of walls. An important part of the present investigation is a laboratory study of the conditions affecting the durability of paint films on steel and galvanized surfaces under conditions somewhat similar to those which might be encountered in service. Special attention is being given to the severity of corrosion resulting from condensed moisture. Painted steel and galvanized metal panels are being tested in the accelerated weathering apparatus, salt spray, and in a condensation corrosion chamber. Similar panels are also exposed outdoors on the roof of the Chemistry Building. Numerous pretreatment solutions for both galvanized metal and plain steel, with about 60 priming paints, are included in the investigation.

An account of this work is given in a new Report on Building Materials and Structures, BMS8, now available from the Superintendent of Documents, Government Printing Office, Washington, D. C., at 10 cents a copy.

CORRELATION OF ELECTROLYTIC CORROSION TEST WITH ACTUAL CORROSIVENESS OF SOILS

Recent studies of the corrosion of pipe lines have shown that there is a certain regularity in the occurrence of leaks and that the total number of leaks which has occurred over a long period of time is related to the soil conditions to which the pipe line has been exposed. The corrosion which has occurred on a pipeline system, measured in terms of the relative length of line that has been repaired, has also been used to express the corrosiveness of a large number of soil types and to correlate the results of laboratory corrosion tests with the corrosion experienced in practice. An accurate record of leaks and replacements, extending over 45 years, on an extensive pipe-line system provided a further opportunity for the investigation of corrosion under actual operating

conditions and for correlating these data with the results of an electrolytic test for soil corrosiveness.

This test consists in the measurement of the polarization voltage at various current densities of a specially designed corrosion cell, in which the electrodes are steel and the electrolyte is the soil under test. The cell is constructed in such a way that the process of corrosion is similar to that in nature. The average current density corresponding to a definite range of potential is taken as the measure of the corrosiveness of the soil.

As described in RP1157 by I. A. Denison and R. B. Darnielle in the Journal of Research for December, samples of soil representing 27 soil types were collected along the right-of-way of a 128-mile section of a pipe-line system, and their corrosiveness was tested by means of the electrolytic corrosion test. When the values were averaged for each soil type and plotted against the number of leaks which had developed on the pipe line in each of the soil types over an average 33-year period, a rough linear correlation was obtained. According to the criterion used, the relative corrosiveness of the soils along approximately 80 percent of the total length of the pipe line was correctly classified.

The influence of certain soil properties on corrosion was indicated by the leak and repair records and by the results of the corrosion test. In a group of associated soils, corrosiveness increased as the drainage became more deficient and as the soil became heavier in texture. The variation in corrosiveness with depth is shown for a number of soil profiles and has been correlated with the aeration and texture of the soil material.

HYDROCARBONS IN THE LUBRICANT FRACTION OF PETROLEUM

Since 1927 the American Petroleum Institute and the Bureau have sponsored a cooperative research on the chemical constitution of petroleum, and by the fall of 1933 considerable progress had been made on the resolution of the gasoline fraction. The advisory committee then decided to investigate the lubricant fraction, using the same lot of midcontinent petroleum.

Five years ago little was known about the general constitution of the dewaxed lubricant fraction and practically nothing of the actual kinds of molecules in it. It was generally assumed, on the basis of a long extrapolation of the data obtained on the gasoline fraction, that the lubricant fraction contained, in addition to the normal paraffins which had been shown to be the constituents of the higher melting waxes, the following types of hydrocarbons: Branched-chain paraffins; molecules composed of naphthene (cycloparaffin) rings with paraffin side chains; molecules composed of aromatic rings with paraffin side chains; and molecules composed of both naphthene and aromatic rings with paraffin side chains. Whether or not these assumptions were correct was one of the questions to be answered. Another was: How do these various kinds of molecules react to the different processes of fractionation, and in which final fractions will they be found?

This broad survey of the chemical constitution of the lubricant fraction, which was conducted by Beveridge J. Mair, assisted at various periods by S. T. Schicktanz, F. W. Rose, Jr., C. B. Willingham, and A. J. Streiff, has now been completed. Six research papers and two general reports to the Institute have resulted, setting forth the procedures employed, the determination of the properties of the fractions obtained, and the correlation of these properties with those of pure hydrocarbons of known molecular structure in order to identify the final "homogeneous" fractions.

A review and summary of the work, with some conclusions, was presented by Frederick D. Rossini, director of the project, before the Division of Refining of the American Petroleum Institute at the annual meeting in Chicago, November 14 to 18. The approximate average analysis of the lubricant fraction of petroleum with respect to kinds of molecules (taking the lubricant fraction as 100 percent) is as follows:

1. About 43 to 51 percent is composed of molecules with 1, 2, or 3 naphthene rings, together with the appropriate paraffin side chains.

2. About 8.3 percent is composed of molecules with 1, 2, or 3 naphthene rings and 1 aromatic ring, together with the appropriate paraffin side chains.

3. About 8.1 percent is composed of molecules with 2 naphthene rings and 2 aromatic rings (condensed), together with the appropriate paraffin side chains.

4. About 6.6 percent is composed of molecules with 1 naphthene ring and 3

aromatic rings (condensed), together with the appropriate paraffin side chains.

5. About 18 to 26 percent is composed of normal (straight chain) paraffins, plus possibly some isoparaffins (branched chain).

6. About 8 percent is composed of the "asphaltic" constituents, which have not been investigated.

PROPERTIES OF PURIFIED NORMAL HEPTANE AND ISOOCTANE

In the past 10 years, normal heptane and 2,2,4-trimethylpentane have been accepted internationally as the primary standard reference fuels for the knock rating of automobile and aircraft fuels. The Bureau was asked by the Cooperative Fuel Research Committee to investigate these materials and to prepare specifications so rigid that acceptable supplies would not differ from perfectly pure material by more than one-tenth of an octane unit.

An investigation of the impurities present in isooctane was reported last year in J. Research NBS 19, 319 (September 1937) RP1027. More recent work described in a paper by Donald B. Brooks in the Journal of Research for December (RP1160) was concerned with the production of *n*-heptane and isooctane of high purity and the measurement of their properties.

The purest available supplies of each of these materials were fractionated through columns having an efficiency equivalent to that of 60 theoretical plates. The density, refractive index, boiling point, and freezing point of the purer fractions of each distillate were measured. In each case the freezing points of the purer fractions were higher than currently accepted values.

PROGRESS REPORT ON SILVER RESEARCH PROJECT

That the great immediate opportunity to develop a tonnage use for silver lies in the field of corrosion-resistant containers is one of the important conclusions in the Seventh Progress Report of the Research Project on New Industrial Uses for Silver. This report, released November 1, 1938, like earlier ones (Technical News Bulletins 244, 249, 252, and 254 (August 1937, and January, April, and June, 1938)), has been prepared in mimeograph form for distribution to the sponsors and interested parties. As previously mentioned in this Bulletin, the project is sponsored by a group of leading American silver-producing companies and has its headquarters at the National Bureau of Standards.

According to the report, a survey has shown that a real need exists for cans, barrels, and other shipping containers more resistant to corrosive attack than some present types in use in the chemical industry, in the canning of certain food products and beverages, in the pharmaceutical, and in the essential oil industries. While canned goods as packaged and marketed today reach the ultimate consumer in wholesome condition, improvement in flavor or color, for example, is still possible for some commodities. In the chemical and allied industries, the containers used in shipping, as well as in the manufacture and storage of chemical products, present troublesome problems. Silver has a remarkable resistance to corrosion by (and, in a corollary manner, to contamination of) foodstuffs and beverages; its chemical inertness to caustic alkalies, to organic acids, and to certain mineral acids and salts is now widely appreciated. According to the survey made by the project, the development of silver-lined containers adaptable to the uses indicated would open up a large potential market for such containers. Statistics available show that if these containers can be manufactured at a reasonable cost, the silver requirement for only those applications now known to the project staff would total some millions of ounces.

If the cost of the containers, etc., is to be within commercially acceptable limits, it is evident that the silver must be applied as a relatively thin coating or lining. Two methods of producing such "coatings" of silver are known to offer a means of obtaining the corrosion resistance of silver at a price probably within commercial limits for specific applications now being investigated. These methods are (a) electroplating and (b) fabrication from silver-clad base metal.

Cooperative work between a commercial can manufacturer, a supplier of silver-clad copper and steel, and the project staff has led to the production of an experimental 12-ounce container for chemicals fabricated from copper or steel sheet 0.012 inch thick which was clad with 0.001 inch thickness of silver. The first of these cans was made some months ago, and since that time attention has been devoted to the possible production of silver-lined cans

at a lower cost, especially larger sizes and other types of can, and to the development of silver-lined barrels.

Naturally the container field is a very broad one, and the research program is concerned with a variety of problems. Silver coatings being investigated may be roughly classified as follows:

Approximate silver thickness	Possible applications
Inches	
0.0002 or less	Food and beverage cans.
0.002	Shipping containers, barrels, etc.
0.02 and up	Chemical apparatus, silver bearings for aviation engines, etc.

All possible methods of applying silver coatings are being investigated. A silver-plating plant has been installed at the Bureau under the supervision of William Blum, chief of the electrochemistry section, to permit pilot-plant operating conditions and the electroplating of material for cooperative tests with industrial concerns interested in developing silver-lined containers. C. S. Lowe and A. C. Simon have been recently added to the Silver Research Project staff at the Bureau and are devoting their full time to this work. Attention is also being devoted to methods of fabricating and joining silver-lined containers, and to studying the corrosion resistance of silver, silver-coated base metal, and silver-soldered joints when exposed to certain products which industry contemplates shipping in these containers.

In the case of silver alloys, the metallurgical program has advanced to the point where tensile test data have been obtained showing the effect of small additions of silver on the properties of a number of commercial alloy types. Were silver as low priced as the more common alloying elements, in many instances the improvement in properties resulting from addition of a small percentage of silver would be of great practical interest. At the present price of silver, each percent of silver added increases the cost of the alloy 6¼ cents per pound. The improved properties commented on below must be balanced against the cost of the silver needed for the improvement, and there is, therefore, the question of practical value to be kept in mind. Attention is called here to the more interesting results obtained without attempting at this time to evaluate the commercial importance of the data. The data on which the observations are based appear in that part of the Seventh Progress Report prepared by the research associates at the National Bureau of Standards.

The following alloys showed that adding 5 percent, or somewhat less, silver notably increased the yield strength of the wrought alloy without commensurate loss in ductility: 80–20 cupronickel, alpha brasses, 5 and 10 percent tin bronzes, 5 percent aluminum bronze, and Everdur (3 percent Si, 1 percent Mn) bronze.

The 10 percent tin bronze, the manganese-silicon bronze, and the 5 percent aluminum bronze were markedly improved by adding 3 to 5 percent of silver to the alloy. In these instances the silver addition induces a response to precipitation hardening heat treatment, although some improvement was observed even without special heat treatment.

Approximately 5 percent of silver added to the wrought eutectic aluminum silicon alloy conferred substantial added hardness at temperatures above the softening temperature of the silver-free alloy. It is expected from the data obtained to date that silver will be found to improve the high-temperature properties of aluminum-rich alloys in general, as well as in the case of the Al-Si alloy mentioned.

Lead-silver soft solders (5 percent silver) have been found to make satisfactory sweated joints in copper tubing assemblies, and such joints have good properties when tested at elevated temperature for long periods of sustained loading.

The research on fungicidal properties of silver compounds at Cornell University has demonstrated the possibility of using a silver spray as a protectant fungicide. Success in this development promises an outlet of some magnitude for silver, and encouraging results are being obtained, since the silver spray solution appears as effective as bordeaux mixture while possessing some advantages, and is of comparable cost.

The research at Battelle Memorial Institute on bearings has brought out advantages which a silver-lead alloy (4 to 6 percent lead) seems to offer when compared with pure silver. Effort is now being made to prepare steel-backed bearings of this alloy by electrodeposition methods.

Research is continuing at Rensselaer Polytechnic Institute on sliding silver contacts. A performance comparison has recently been made between latest

model starter motors equipped with copper-graphite and silver-graphite brushes.

A study of temperature-pressure and time relationships in the cold-welding of silver has been completed at Lehigh University. Cold-welding was observed at temperatures as low as 200° C.

KASSON S. GIBSON RECEIVES AWARD FROM SOCIETY OF MOTION PICTURE ENGINEERS

The Journal Awards Committee of the Society of Motion Picture Engineers has chosen a paper entitled "The Analysis and Specification of Color" as "the most outstanding paper originally published in the Journal of the Society of Motion Picture Engineers during the year 1937." This paper was contributed by Kasson S. Gibson, chief of the Bureau's section on colorimetry and spectrophotometry, and was published in the April 1937 issue of the above Journal.

CONCRETE AS PROTECTION AGAINST X-RAYS

Although the danger of prolonged exposure to X-rays was recognized soon after their discovery by Roentgen, many of the early workers in this field suffered injury before it was learned that a worker could protect himself by interposing proper screens between himself and the X-ray tube. The denser the screening material the greater was the degree of protection observed for screens of equal thickness. For this reason lead came into common use as a protective material, both in metallic form and in combination with other substances, as in lead-glass and lead-rubber. The penetrating power of the X-radiation in common use has increased very much in recent years; with this trend lead screens of increasingly greater thickness were required until today the cost of lead for protection against the more penetrating radiation may be a considerable part of the total cost of the X-ray installation. The cost of the lead itself is only a part of the expense of lead protection, since elaborate supporting substructures are required. Moreover, few existing hospitals or laboratory buildings can take the additional load.

Since new buildings must in most cases be built, or old structures remodeled and reinforced, and since such construction is usually in concrete, the possibility of using concrete both as a structural material and as a protective barrier suggests itself. In a recent study by George Singer, L. S. Taylor, and A. L. Charlton, reported in the December Journal of Research (RP1155), the protective properties of a selected group of prepared concrete samples and commercial building blocks were determined. It was found that the protective qualities did not depend upon the nature of the concrete mix but only on the mass of the barriers. Furthermore, the protective value of concrete was greater for X-rays of greater penetrating power, so that the concrete thickness required for protection at 400 kv was only slightly greater than that required at 200 kv. Curves for calculating the thickness of concrete needed for complete protection were obtained.

In any case, however, the weight of the concrete required was found to be greater than that of lead for the same degree of protection, but this is no serious disadvantage since concrete is cheap and requires no external supports. For the more penetrating radiation concrete is a protective material of considerable merit.

CRYSTALLINE SILICA IN CERTAIN DEVITRIFIED GLASSES

In RP1152 in the Journal of Research for December, A. Q. Tool and H. Insley describe experiments in which samples of a borosilicate glass containing a relatively high percentage of silica were devitrified and further treated at various temperatures between 625° and 950° C. The cristobalite, tridymite, and quartz formed in this way were investigated by observing their inversion effects in heating and cooling curves and by microscopic examinations and X-ray tests. The results indicate the possibility that tridymite at atmospheric temperatures ordinarily consists of at least two forms, each having one rapid inversion, but that the two generally recognized inversions of this material do not occur in a single crystal unless it is an aggregate of the two forms. Presumably such a heterogeneous crystal appears during the sluggish transformation from one form to another. In devitrified materials of the kind investigated, numerous crystals of both forms and crystalline aggregates representing all degrees of heterogeneity are likely to be present unless the transformation is definitely completed.

Such heterogeneities may be the cause of the well known shifts in the inversion points of both cristobalite and tridymite and consequently of the great variation in the published results for these points.

When a great variety of degrees of heterogeneity exists in the same test sample the inversion effects will then cover a correspondingly broad temperature range and may become very indefinite and possibly almost undetectable. Inversion effects of this nature are well known in the case of tridymite.

In this investigation it was noted that tridymite plates always appeared first and were more numerous than the wedge-shaped twins as long as the inversion effects near 150° C were (1) the only tridymite effects appearing, or (2) were much more prominent than the effects at the lower inversion temperatures near 100° C. As the plates disappeared, wedge-shaped twins took their place and the inversion effects near 100° C assumed ascendency and ultimately became the only tridymite effects present if the transformation treatments were continued.

INVERSION OF SILICA CRYSTALS IN CERTAIN DEVITRIFIED GLASSES

The expansion effects found in a devitrified borosilicate glass and caused by the rapid inversions of cristobalite, tridymite, and quartz were recently investigated by A. Q. Tool and J. B. Saunders. A report on this study will be published as RP1153 in the December Journal of Research. The devitrification was accomplished by heat treatments at 800° C, and the progressive transformation of the crystalline products from cristobalite through tridymite to quartz was developed by increasing the duration of the heat treatments. Since the glass contained a relatively high percentage of available silica, the yield of these products was comparatively large. As a result, the expansion effects were positive and gave a clear picture of the course of the sluggish transformations as the duration of the heat treatments was increased. In the case of tridymite the results suggest that its two recognized rapid inversions are not, as generally supposed, two sequential changes in form occurring within the same homogeneous crystal. Instead it seems that the inversion which usually occurs in the range 140° to 165° C and appears first with the development of tridymite is a form-change in a different type of crystal from that which develops later and undergoes an inversion or form-change in the range 80° to 120° C. Ordinarily, however both of these possible types of crystals appear in the same sample after treatments producing only partial transformation and there is also the possibility that there are some inhomogeneous crystals which are a mixture of both types.

RESISTIVITY AND POWER INPUT IN THE CESIUM DISCHARGE

In his studies of the cesium discharge, measurements have been made by Fred L. Mohler, chief of the Bureau's section on atomic physics, radium, and X-rays, of the potential gradient and the ion current to the tube wall in a tube 5 mm in diameter, for current densities ranging from 5 to 20 amperes and vapor pressures from 0.0045 to 0.33 mm. Potential gradients have also been measured in a 1-mm tube for current densities from 30 to 150 amperes per cm^3 and pressures from 0.33 to 2 mm. Published results give electron concentrations and temperatures for this range of conditions. The resistivity agrees approximately with the theoretical value for a completely ionized gas. The power dissipation comes predominantly from wall recombination at low pressures. Above 0.17 mm the radiation is appreciable and above about 1 cm the radiation would account for most of the power input. The report on this work (RP1162 in the Journal of Research for December) gives theoretical equations for the case that pressure and degree of ionization are so high that the vapor is opaque.

PORTABLE GEIGER COUNTER UNIT

A portable instrument for measuring the strength of radium preparations, surveying radium dial painting plants, examining radioactive ores, and for detecting lost radium has been developed by L. F. Curtiss of the Bureau's atomic physics, radium, and X-rays section. The complete instrument weighs only 13 pounds and is entirely self-contained, so that it can be used anywhere.

The instrument employs an integrating counter circuit, operated by dry cells carried in the case. Recent tests of the circuit show that it is sensitive to one millionth of a gram of radium at a distance of one meter, and as it is capable of more or less accurate calibration, quantitative results are possible.

As an aid in locating lost radium, the instrument should be particularly val-

uable since it can detect one milligram (a very small medical preparation) at about 30 meters.

For a complete description of the apparatus, RP1154 in the December number of the Journal of Research should be consulted.

ACCURACY OF RADIO FIELD-INTENSITY MEASUREMENTS AT BROADCAST FREQUENCIES

A report on the attainable accuracy of radio field-intensity measurements at radio frequencies below and within the broadcast band is given in a joint paper (RP1156 in the December Journal of Research) by Harry Diamond and E. G. Lapham, of the Bureau, and K. A. Norton of the Federal Communications Commission. Accurate measurement of the intensity of the field set up by broadcast stations is essential for evaluating their service areas. The report presents an analysis of the types of errors encountered in typical commercial field-intensity measuring sets and gives quantitative data on the magnitudes of the errors. Based on these data, an estimate is made of the over-all absolute accuracy of commercial equipment. Before applying correction factors for the several errors, the accuracy of measurement may be no better than about 20 percent. After application of suitable correction factors, an accuracy of 5 percent may be attained.

Factors likely to lead to errors in field intensity measurements in typical equipment include: (a) incorrect calibrating voltage; (b) nonlinearity of the detector and of the output indicator system; (c) incorrect voltage-attenuator design; (d) incorrect balance of the loop antenna; (e) stray voltages induced in the loop antenna by the calibrating oscillator or from other portions of the set; (f) regeneration in various portions of the set; (g) distortion of the field by the set container or by mounting of the loop antenna on an automobile; and (h) the difference in effect of distributed capacitance of the loop antenna upon its voltage step-up for the distributed field voltage and for a lumped calibrating voltage.

The distributed capacitance effect appears to have been given scant consideration in the design of commercial apparatus. The error produced is a function of the ratio of the operating frequency to the natural frequency of the loop antenna. In some commercial sets in which the loop antenna operates near its natural frequency to reach the upper broadcast frequencies, this error reaches a magnitude of 15 percent. The report includes a theoretical analysis of this error and presents derived correction factors to be applied in order to obtain more accurate measurements. The correction factor is shown to be a function of the current distribution in the loop antenna, which is, in turn, a function of the distributed capacitance. Four assumptions of current distribution are considered, and corresponding correction factors are derived. The factor derived on the basis of elliptical current distribution is shown to have better basis in theory and agrees closely with experimental measurements.

Finally, several means are described for eliminating or limiting the distributed capacitance error by special design of the set. These include the use of the condenser-variation method for measuring the voltage step-up of the loop antenna, the use of an untuned loop antenna wherein no voltage step-up is involved, the use of a shielded loop antenna having an unbalanced current distribution, the deliberate unbalance of the two halves of the loop antenna to ground, or the use of two or more loop antennas for covering the broadcast band so that no antenna operates near its natural frequency.

Included in the report is a discussion of the precautions necessary in obtaining accurate field-intensity measurements when the measuring set is installed in an automobile, a practice adopted by many engineers.

IONOSPHERE CHARACTERISTICS FOR HALF A SUNSPOT CYCLE

The sun is the principal source of the energy which produces the ionization of the earth's upper atmosphere. Changes in solar activity, as manifested by changes in sunspot numbers, in general, produce corresponding changes in the ionization of the various layers of the ionosphere and consequent changes in the characteristics of radio sky-wave transmission. A paper (RP1159) by Newbern Smith, T. R. Gilliland, and S. S. Kirby in the Journal of Research for December shows that the increase of sunspot numbers, from the minimum of 1933 to 1938 has been accompanied by a general increase in the values of the critical frequencies of the ionosphere layers. In the case of the E layer, there has been good general correlation between critical frequency and sunspot

numbers, the former increasing to 1¼ times the value it had at the sunspot minimum. In the case of the F_2 layer, the correlation has not been so good in detail and the increase in its critical frequency has been much larger. The critical frequency reached a value twice as great as at the sunspot minimum.

The long-period increases in sunspot numbers and critical frequencies are studied in some detail in the graphs of this paper and the regular diurnal and seasonal variations in critical frequencies are also summarized. The short- and long-period variations in ionosphere characteristics appear to be so well marked as to suggest the possibility of forecasting the average condition of the ionosphere and radio-transmission conditions, months and even years in advance.

METHODS OF TESTING HOSIERY

Bureau's methods of analysis and tests for hosiery, which are likewise recognized as the best practice by other laboratories, are described and discussed in Circular C422 which has just been released. This circular was prepared by E. Max Schenke and Howard E. Shearer, research associate and assistant research associate, respectively, of the National Association of Hosiery Manufacturers, Inc. These methods have been reviewed and approved by the Committee on Standards of this association and by the Knit Fabrics Committee of the American Association of Textile Technologists. The new publication makes the methods available to manufacturers, commercial testing laboratories, home economics teachers, distributors of hosiery, and all others interested.

The object of a laboratory analysis or test of hosiery may be to provide data for calculating the cost of production, or to make exact reproduction possible. It may be necessary to determine the difference between two stockings, or to ascertain and describe defects and variations in yarns, or constructions, or to compare service quality.

Circular C422 contains discussions of the visual examination of hosiery for type and workmanship; methods for measuring the size and dimensions of the various parts; directions for analyzing the construction of fabric and yarn; and outlines of tests for physical properties, color fastness, and shrinkage; in other words, a complete picture of hosiery analysis, is presented.

Copies of the circular are obtainable from the Superintendent of Documents, Government Printing Office, Washington, D. C., at 15 cents each.

NEW AND REVISED PUBLICATIONS ISSUED DURING NOVEMBER 1938

Journal of Research[2]

Journal of Research of the National Bureau of Standards, volume 21, number 5, November 1938 (RP1142 to RP1150, inclusive). Price 30 cents. Annual subscription, 12 issues, $3.50.

Research Papers[2]

[Reprints from the July 1938 Journal of Research]

RP1110. Pressure losses for fluid flow in 90° pipe bends. K. Hilding Beij. Price 10 cents.

RP1115. Determinations of oxygen in alloy steels. John G. Thompson and Vernon C. F. Holm. Price 10 cents.

Circulars[2]

C422. Methods of testing hosiery. E. Max Schenke and Howard E. Shearer. Price 15 cents.

Building Materials and Structures[2]

BMS4. Accelerated aging of fiber building boards. Daniel A. Jessup, Samuel G. Weissberg, and Charles G. Weber. Price 10 cents.

BMS8. Methods of investigation of surface treatment for corrosion protection of steel. Rolla E. Pollard and Wilbur C. Porter. Price 10 cents.

Technical News Bulletin[2]

Technical News Bulletin 259, November 1938. Price 5 cents. Annual subscription, 50 cents.

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[2] Send orders for publications under this heading only to the Superintendent of Documents, Government Printing Office, Washington, D. C. Subscription to Technical News Bulletin, 50 cents per year; Journal of Research, $3.50 per year (United States and its possessions, and Canada, Colombia, Cuba, Dominican Republic, Ecuador, Guatemala, Honduras, Mexico, Newfoundland (including Labrador), Panama, and Venezuela); other countries, 70 cents and $4.50, respectively.

MIMEOGRAPHED MATERIAL

Letter Circulars

Letter Circulars are prepared to answer specific inquiries addressed to the National Bureau of Standards and are sent only on request to persons having definite need for the information. The Bureau cannot undertake to supply lists or complete sets of Letter Circulars or send copies automatically as issued.

LC534. Commercial testing laboratories equipped for chemical analysis. (Replaces LC196.)

LC535. Aluminum foil insulation. (Replaces LC465.)

LC536. Inorganic analytical chemistry; Publications by the staff of the National Bureau of Standards (1901–1938).

RECENT BUREAU ARTICLES APPEARING IN OUTSIDE PUBLICATIONS[3]

A method for the investigation of upper-air phenomena and its application to radio meteorography. H. Diamond, W. S. Hinman, Jr., and F. W. Dunmore. Proc. Inst. Radio Engineers (33 West 39th St., New York, N. Y.) **26**, 1235 (1938).

Performance tests of Navy radio meteorograph system. H. Diamond, W. S. Hinman, Jr., and E. G. Lapham. J. Inst. Aeronautical Sciences (30 Rockefeller Plaza, New York, N. Y.) **5**, 484 (October 1938).

Soil corrosion and pipe line protection. (Book.) Scott Ewing (Am. Gas Assn., 420 Lexington Ave., New York, N. Y.) (October 1938). (Obtainable from Association at $2.50 a copy.)

The International Bureau of Weights and Measures. Lewis V. Judson. Scale Journal (1703 East 84th St., Chicago, Ill.) **25**, 10 (October 1938).

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[3] These publications are not obtainable from the Government. Requests should be sent direct to the publishers.

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